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(54) Video picture stabilising system

(57) A video picture stabilising system wherein a video input from a camera 11 is converted to digital form and stored sequentially in memory 17 starting from a variable address (offset from the beginning of the memory block). The variable offset address is obtained from the motion sensing circuits 10, by an interface unit 14 and is thus determined by the amount of shift of the camera from a mean position. The memory locations are read out sequentially and converted back to analog form, but here the addressing starts at a fixed address, the beginning of the memory block. This introduces a delay and hence offset in the output data. However, this offset is determined by the variable offset address and hence the camera shift or offset from its mean position. Thus, this introduced controllable offset can compensate for the offset introduced into the video picture signal by the shifted camera position. Therefore, the analog output from the complete system when displayed will show the scene without any offset i.e. as if the camera were still at its mean position.

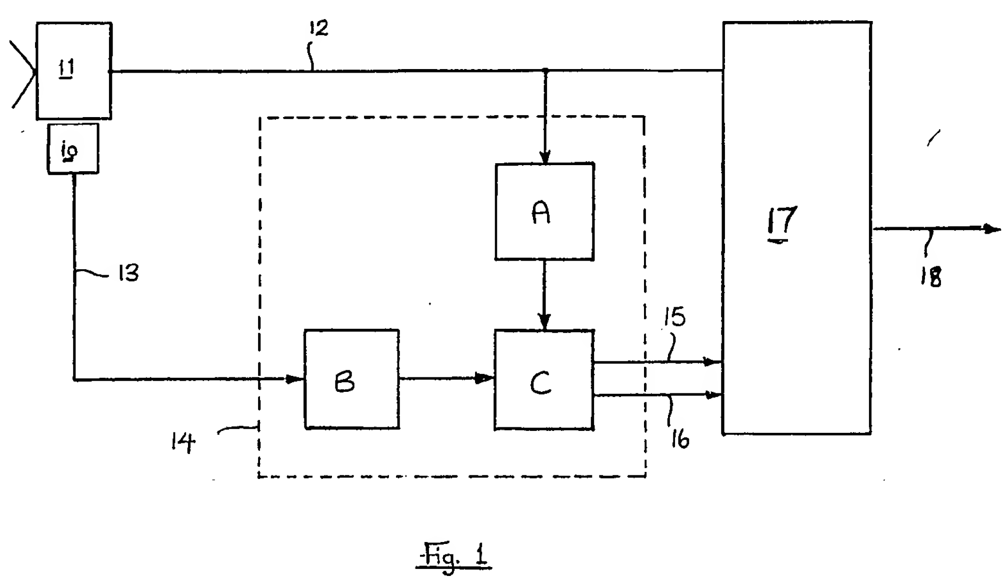

Fig. 1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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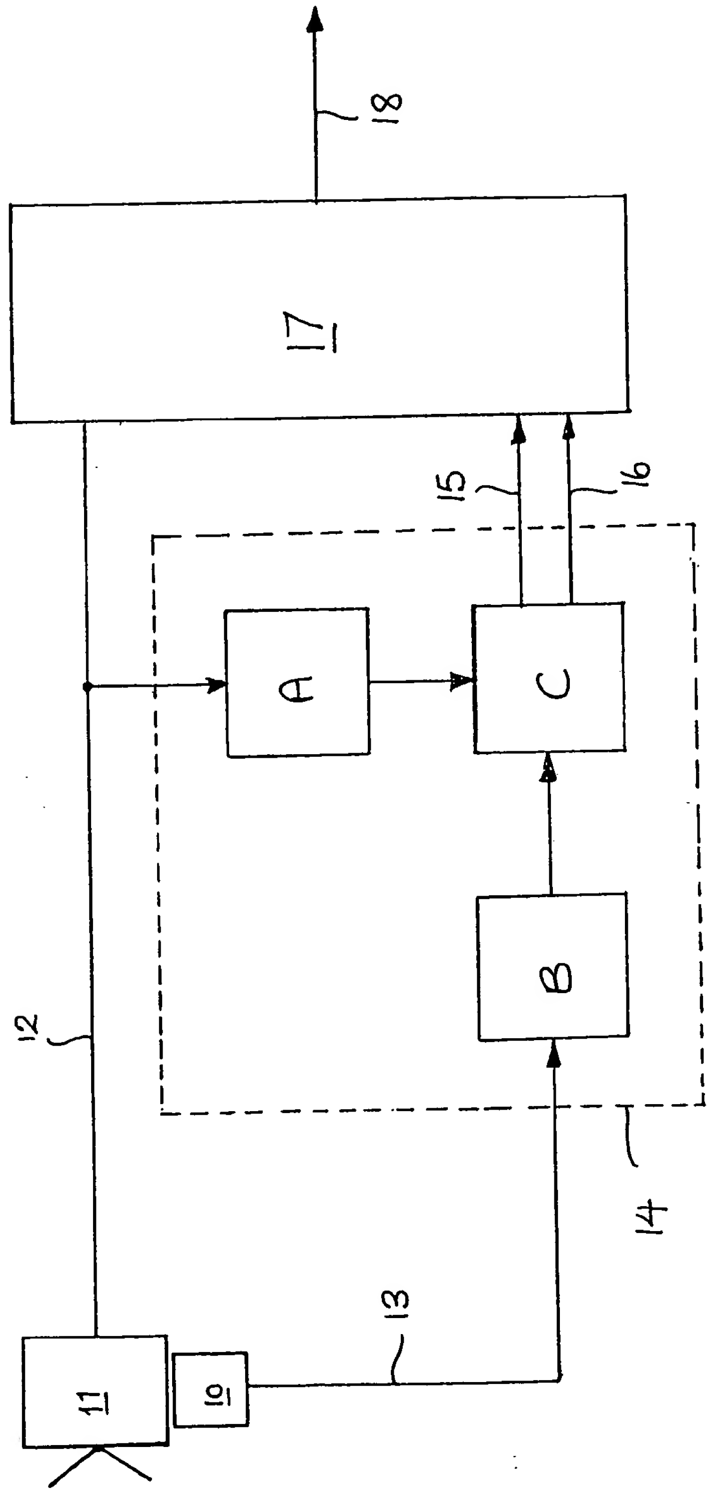


Fig. 1

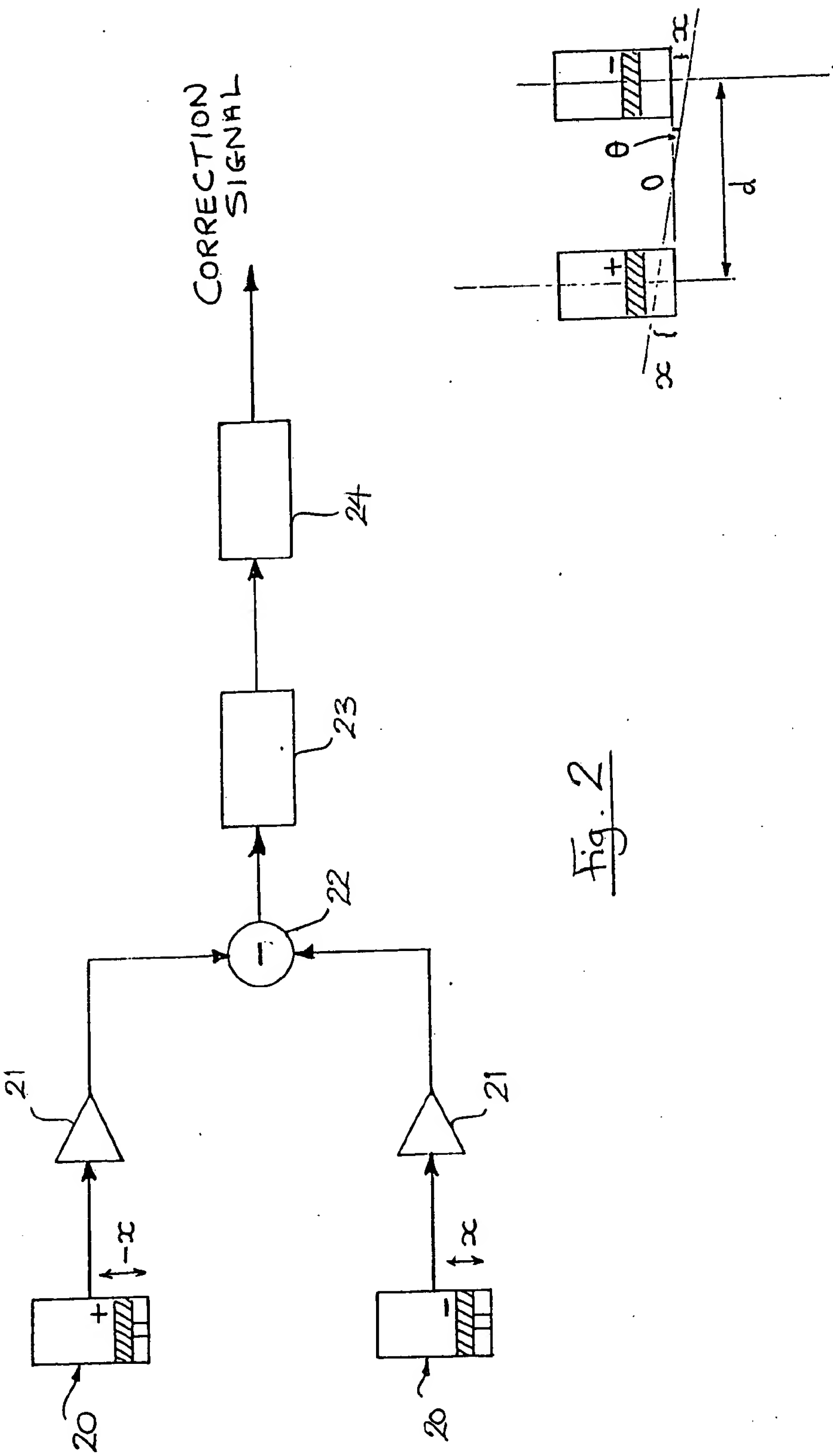
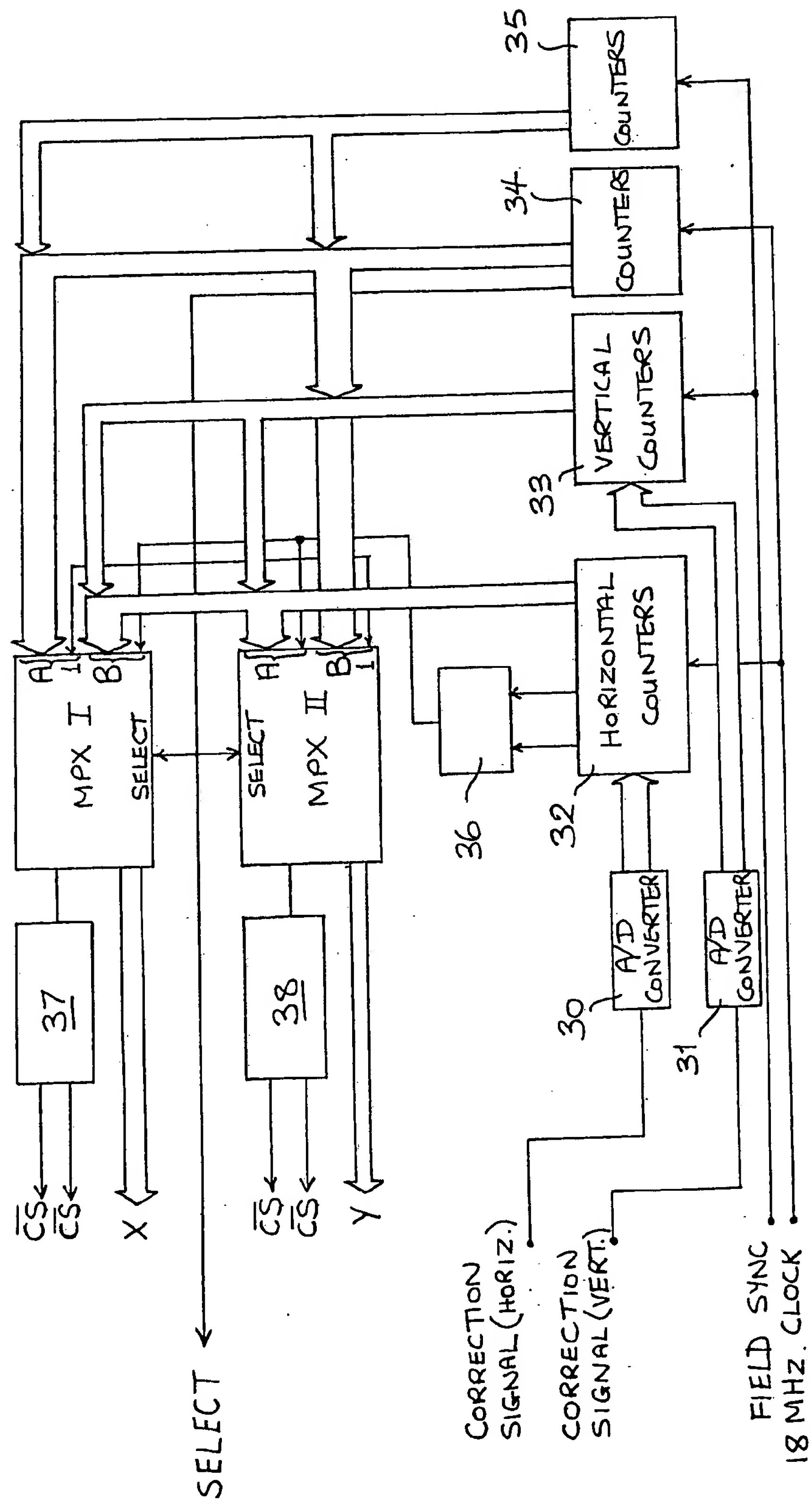


Fig. 2



COUNTERS
35
COUNTERS
34
VERTICAL COUNTERS
33
HORIZONTAL COUNTERS
32
36
A/D CONVERTER
30
A/D CONVERTER
31
MPX I
SELECT
MPX II
SELECT
A
1
B
37
38
CS
CS
X
CS
CS
Y
SELECT
CORRECTION SIGNAL (HORIZ.)
CORRECTION SIGNAL (VERT.)
FIELD SYNC
18 MHz. CLOCK

Fig 3a

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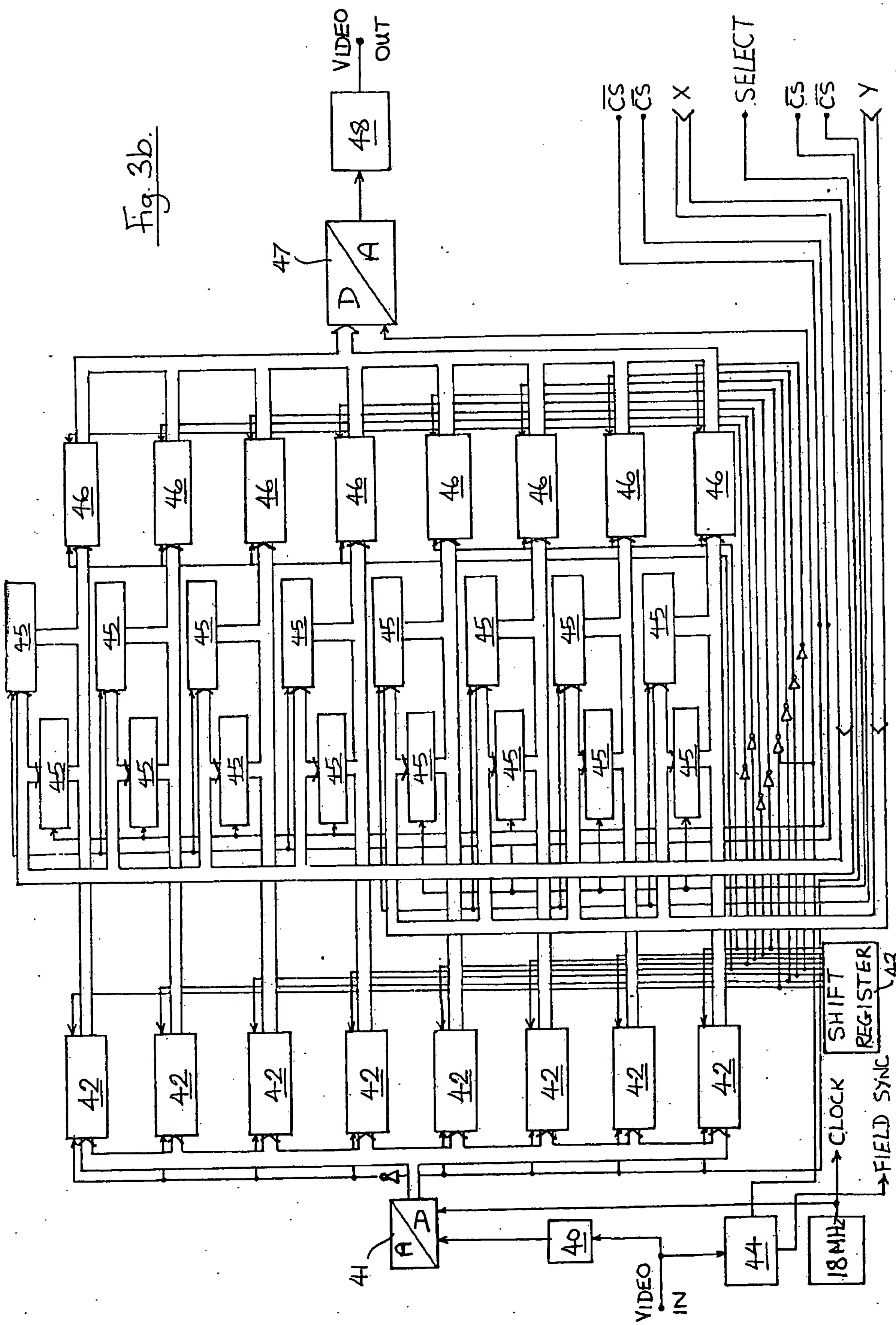

Fig. 3b.

SPECIFICATION

Video picture stabilising system

The present invention relates to a method and apparatus for stabilising a television picture derived from the output signals from a camera which is being disturbed by some form of vibration or motions such as could arise from the motion or vibration of a vehicle or person carrying the camera.

Upon the present time, various attempts have been made to provide mountings for television cameras to reduce the effects of the motion of a cameraman carrying the camera, or the motion and vibration of a vehicle or aircraft, on the picture produced by the camera. The majority of such previous systems comprise a mechanical mounting arrangement to absorb and compensate for such undesired movement or vibration, but such devices can clearly be cumbersome and are not wholly effective.

Accordingly, it is the object of the present invention to provide an electronic system by means of which a stable television picture can be derived from the output signals of a camera by electronically sensing the movement of the camera and compensating for such movement in order to produce a picture which is free from disturbances due to vibration or motion of the camera.

According to the present invention there is provided a video picture stabilising system comprising a motion sensing unit attachable to or incorporated in a video camera for sensing movement of the camera and providing output signals representative of any such movement, and a picture stabilising unit for receiving said output signals from said motion sensing unit and the video output signal from said camera, said picture stabilising unit including means for correcting said video signal in response to said signals from said motion sensing unit in order to enable a corrected video signal to be provided which is compensated for unwanted motion or vibration of the camera in use.

Preferably, the motion sensing unit includes motion sensitive transducers mounted on the camera and so positioned that they are sensitive to the motion whose effects are to be suppressed. Such motion sensing unit may be provided as an attachment to a conventional camera or, if desired, may be incorporated in a video camera with suitable modification thereof.

The picture stabilising unit which is attachable to the motion sensing unit and the output of the camera by suitable cables and/or radio link may be provided as a separate unit interposed between the video camera and video signal receiving means, such as a video recorder or the like and/or a television monitor, or the picture stabilising unit could be incorporated in a video recorder or monitor, as required.

The picture stabilising unit utilises the signals from the motion sensing unit to correct the position of the elements of the displayed camera picture so that the original unwanted camera disturbances are minimised and for this the picture stabilising unit has the ability to move the picture element content of the video signal with respect to its line and frame synchronising signals.

The present invention will now be described further with reference to the accompanying drawings, in which:

Fig. 1 is a schematic block diagram of a basic video picture stabilising system according to the present invention illustrating the principle of operation;

Fig. 2 is a schematic block diagram of a motion sensing unit of the video picture stabilising system; and

Figs. 3a and 3b are block schematic diagrams of the preferred embodiment of a video signal correction unit.

Referring now to Fig. 1 in more detail, a motion sensing unit 10 is shown associated with the video camera 11 and may be either attachable thereto or may be incorporated in the video camera 11 by appropriate modification thereof. The output video signal from the camera 11 is output on line 12 whilst the signals from the motion sensing unit 10 are output on line 13. An interface unit 14 receives both the video signals from line 12 and movement signals from line 13 and from these signals provides error control signals on lines 15 and 16 which are supplied as inputs to a store 17, which also receives the camera video signal on line 12. The store 17 has an output 18 for the corrected video signal.

The motion sensing unit 10, attached to the video camera 11, houses transducers which are sensitive to the vibration or motion, whose effects are, as far as practicable, to be suppressed. Suitable transducers could use piezo-electric material in conjunction with a suitable seismic mass. The camera 11 has three linear degrees of freedom and three rotational degrees of freedom, and transducers may be fitted as required according to the intended application, to sense any, or some, or all of these motions of the camera. In most applications it is anticipated that rotation about the vertical axis, which would cause horizontal motion of a display picture, and rotation about the horizontal axis, which would cause vertical motion of the displayed picture, would be the principle motions to be corrected, however, all axes may be corrected.

In general, each camera axis for which motion signals are required, would have a transducer or transducers mounted on it to convert the motion to be sensed into a suitable electrical signal. The signal would in general contain very little energy and therefore a conventional low-noise amplifier would be required to amplify the low level transducer signal. The transducer signals are transmitted via a suitable cable 13 to the interface unit 14 either as analog signals, or coded in some other convenient form (e.g. digital modulation, frequency modulation, amplitude modulation or delta-sigma modulation).

The interface unit 14 in combination with the store 17 provides a picture stabilising unit which has the ability to move the picture elements content of the video signal with respect to their line and frame synchronising signals. These movements are controlled from the signals derived from the motion sensing unit 10 mounted on the camera 11 and supplied to the interface unit 14. The store 17 and the interface unit 14 may be provided in a single unit, but could alternatively be separate units located remote from one another and appropriately inter-connected, if called for.

The interface unit 14 comprises three principle functional blocks, indicated in Fig. 1 as blocks A, B and C. Block A receives the output video signal from the camera 11 on line 12 and extracts the line and field synchronising information from this video signal and provides these synchronising signals as inputs to block C. Block A is similar to conventional sync separators, as used in television receivers and monitors, and utilises commonly available electronic components.

Block B of the interface unit 14 receives the incoming signals from the motion sensing unit 10, which signals constitute position error information, and presents these signals in a suitable form as inputs to block C. In the basic system, these signals are analog and, for the purposes of the principle of the system being described, do not undergo any form of signal processing.

Block C of interface unit 14 receives the synchronising pulse signals from block A and the position error information from block B and combines them in a manner to generate suitable control signals for the store 17.

The store need not store more than an amount of picture data sufficient to cover the expected range of picture motion to be corrected at the time of recording.

The store 17 receives video picture information on line 12 and line and frame control signals on lines 15 and 16, the incoming video picture information being turned into a form convenient for storage, e.g. to a digital form utilising an analog to digital converter, and stored, e.g. in a random access memory. The original picture position error, as measured by the motion sensing unit 10 on the video camera 11, or by other means is translated by the raster generation to a time delay error. This error can be corrected by varying a delay between reading into and out of a video store in a suitable manner. It is possible to record both video information and position error information for use at a time later than that of the original recording. The delay referred to above can, if later correction is to be applied, be positive or negative. The delay variations are referenced to the raster synchronising signals for the purposes of picture error correction.

With the system as described, the stabilised output picture will be smaller than the original unstabilised picture area and will not utilise the full picture area unless further video processing is carried out. A system has been described which is capable of suppressing unwanted motion or vibration of a video picture thereby producing a stabilised picture from an unstabilised picture (e.g. one from a camera which is being disturbed by some form of vibration).

Referring now to Fig. 2, this illustrates a possible construction of a suitable motion sensing unit for sensing motion about a single axis and utilises a pair of motion sensing transducers 20 using a piezo-electric material in conjunction with a seismic mass. The outputs of the two transducers 20 are applied to respective low noise pre-amplifiers 21, the outputs of which are subtracted in a subtractor 22 and supplied as an input to an integrator 23, the output of which is then supplied to a further integrator 24, the output of which is a signal representative of the angular displacement θ of the transducers 20. The linear motion of each transducer along the sensitive axis is indicated as χ, whilst d represents the distance between the transducers, and θ is the angular displacement of the transducers.

The response of the motion sensing unit may be shaped electronically to give characteristics suited to a particular application, and in particular, the response may be so shaped that when, for example, a cameraman operating the camera wishes to pan from one subject to another, or when following a moving object, the correction response of the system is negligible whilst still providing correction to higher frequency disturbances. This may be done, for example, by changing the integrators in the system from pure integrators with a transfer function of the form $V_o=1/_{pt}.(V_{in})$ to integrator-like circuits with a transfer function of the form $V_o=1/_{(1+pt)}\cdot(V_{in})$.

Referring now to Figs. 3a and 3b, these together show a preferred schematic diagram of a video picture signal correction circuit. The correction signals from the motion sensing unit associated with a camera, are applied to analog-to-digital converters 30 and 31, wherein the analog output from the motion sensing circuits is converted to digital form during the line period and hold this data at their respective outputs during line sync (for converter 30) or for field sync (for converter 31) periods.

The output of analog-to-digital converter 30, which represents the horizontal displacement indicated by the horizontal correction signal in digital form is loaded into counters 16 during line sync and this data then forms the preset starting point for the horizontal position value from which the following count derived from the clock commences for one line. The output of the analog-to-digital converter 31, which represents the vertical correction signal in digital form, is provided as the input to counters 33 during field sync, and this data then provides the preset vertical position value and forms the starting point for counting derived from the field sync pulses.

Further counters 34 and 35 are provided, with counter 34 being of conventional type counting during one line and clearing during line sync. The

input to counter 34 is driven by the clock. Counter 35 increments each line and clears during field sync and is driven by the line sync pulses.

The output of counters 32 to 35 are each applied to respective inputs of multiplexers MPX I and MPX II. The output of horizontal counters 32 comprises the 7 most-significant address lines which are supplied to the A inputs of multiplexer MPX II and to the B inputs of multiplexer MPX II and to the B inputs of multiplexer MPX I, whilst the 2 least-significant counts from horizontal counters 32 are applied to a logic circuit 36, which generates a write enable signal $\overline{WE}$, which is applied to both multiplexers MPX I and MPX II. The output from vertical counters 33 comprises 5 address lines, which are respectively applied to the A inputs of multiplexers MPX II and the B inputs of multiplexer MPX I. The output of counters 34 comprises the 7 most-significant address lines which are applied to the A inputs of multiplexer MPX I and B inputs of multiplexer MPX II, the 3rd least-significant address line being provided as a separate to provide a "select" signal from multiplexers MPX I and MPX II, the two least-significant counts from counter 34 being ignored. The output from counter 35 comprises five address lines which are applied to the A inputs of multiplexer MPX I and the B inputs of multiplexer MPX II. A further input is provided to multiplexers MPX I and MPX II, namely a logic "1" input.

The multiplexers MPX I and MPX II each select from their two inputs (A or B) according to the logic signal at the select input, i.e. 0 or 1. Multiplexer MPX I, with select at 0, allows through the address lines from counters 34 and 35 plus logic 1 (for write-enable signal $\overline{WE}$), whilst if the select input is at 1, it allows through the address line from the horizontal and vertical counters 32 and 33 plus the write-enable signal $\overline{WE}$. Conversely, multplexer MPX II, with select at $\bar{0}$, allows through the address lines from the horizontal and vertical counter 32 and 33 plus the write-enable signal $\overline{WE}$, whilst with select at 1, it allows through the address lines from counters 34 and 35 plug logic 1 (for write-enable $\overline{WE}$). Thus, the outputs of multiplexers MPX I and MPX II both comprise twelve address lines plus a write-enable signal $\overline{WE}$. In addition, a further output is taken from multiplexers MPX I and MPX II, which is respectively applied to logic circuits 37 and 38, each of which take the most-significant address lines and provide two outputs, one a copy of the most-significant address and the other an inverted copy of the most-significant address to provide two chip-select signals $\overline{CS}$. The various outputs from the multiplexers MPX I and MPX II third least-significant address line from the third least-significant address line from counter 34 are applied to the second half of the video signal correction circuit shown in Fig. 3b, as indicated.

Referring now to Fig. 3b, the video signal supplied by the camera is input to a buffer amplifier 40 and subsequently to a high speed analog-to-digital converter 41. The video input, converted into digital form, is then applied to eight 8-bit latches 42 during latch-enable pulses ($\overline{LE}$) supplied by an 8-bit shift register 43, loading the parallel logic pattern 10 000 000 during the line sync period, and rotates this pattern around in a shift right direction at the clock frequency at all other times. The data input to the latches 42 is stored by them until an output enable signal ($\overline{OE}$) is applied to the latches 42, this output enable signal ($\overline{OE}$) being derived from the select signal derived from the third least significant address line of counter 34 of Fig. 3a. The video input signal is also applied to a sync separator 44, which produces two TTL level pulse trains corresponding to composite sync (field and line) and field sync patterns. The field sync pulses being used as previously referred to in connection with Fig. 3a, whilst the composite sync signals are used to reconstruct the video signal at the output, as will be described later.

While the video input is stored in latches 42, the correction signals supplied by the motion sensing circuit are processed as previously described in connection with Fig. 3a. and the outputs X and Y of multiplexers MPX I and MPX II, each of which comprise twelve address lines plus a write-enable signal $\overline{WE}$, are applied to a block of sixteen 2Kx8-bit memory chips 45 under the control of chip-select signal $\overline{CS}$ to produce variable offset addresses in the memory 45. The video input converted into digital form is then stored sequentially in memory 45 starting from the variable offset addresses, which corresponds to the amount of shift on the camera from a mean position as detected by the motion sensing circuits. The memory locations are then read out sequentially from memory 45 and stored in a further eight 8-bit latches 46, during latch-enable pulses received from shift register 43, addressing in this instance starting a fixed address, namely the beginning of the memory block, which thereby introduces a delay and hence offset in the output data. This offset is determined by the variable offset address and hence the camera shift or offset from its mean position.

The data stored in the latches 46 is output in accordance with an output-enable signal $\overline{OE}$ derived from the shift register 43 and input to a digital-to-analog converter 47, which also receives the composite sync pulses from sync separator 44. The digital-to-analog converter 47 sums the data from the various latches 46 and combines this with the composite sync pulses in correct proportions to reproduce a composite video signal, which is then output to a buffer amplifier 48 to provide an appropriate corrected video output of analog form, which when displayed will show the picture without any offset, i.e. as if the camera was stationary at its means position.

Thus, the video picture signal stabilising system provides for compensation of the video signal for undesired movement or vibration disturning the picture quality.

Claims

1. A video picture stabilising system comprising, a motion sensing unit for attachment to or incorporated in a video camera for sensing movement of the camera and providing output signals representative of any such movement, and a picture stabilising unit for receiving said output signals from said motion sensing unit and the output signal from said camera, said picture stabilising units including means for correcting said video signal in response to said signals from said motion sensing unit in order to enable an output video signal to be provided which is compensated for unwanted motion or vibration of the camera in use.

2. A video picture stabilising system as claimed in claim 1, wherein the motion sensing unit includes one or more motion sensitive transducers for sensing movement along one or more axes about which movement can take place.

3. A video picture stabilising system as claimed in claim 2 wherein motion sensitive transducers are provided in pairs associated with each axis of movement to be sensed.

4. A video picture stabilising system as claimed in claim 2 or 3 wherein the motion sensitive transducers utilise a piezo-electric material in conjunction with a seismic mass.

5. A video picture stabilising system as claimed in any preceding claim, wherein means are provided for processing the outputs of the motion sensing unit to produce control signals for correcting the video signal to compensate for undesirable movement of the camera.

6. A video picture stabilising system as claimed in claim 5, wherein the said processing means includes means for deriving variable offset addresses from said correction signals received from the motion sensing unit, means for converting the camera video signal into digital form, memory means for receiving the digitized video input offset by an amount determined by said offset addresses derived from the motion sensing unit, and means for converting the offset digitized video signal into analog form to produce a corrected video output.

7. A method of stabilising a video picture derived from output signals from a camera to remove unwanted vibration or motion, comprising:

sensing movement of a camera whose output signal is to be corrected and producing one or more correction signals representative of movement detected; and

processing said output signal to be corrected utilising said correction signals to produce a corrected video signal which is compensated for unwanted motion or vibration.

8. A video picture stabilising system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

9. A method of stabilising a video picture derived from output signals from a camera to remove unwanted vibration or motion, substantially as herein described.

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